INSTRUCTION MANUAL

MODEL-CR110-30

INTERMEDIATE REGULATION SERIES

TRANSITORIZED POWER SUPPLY

TRYGON ELECTRONICS
SUBSIDIARY
SYSTRON DONNER

1200 SHAMES DRIVE • WESTBURY, N.Y. 11590

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ADDENDUM

Auto-Paralleling of CR Series Power Supplies

These instructions apply to units with serial numbers above 288101 or, in some instances, units retrofitted with this feature, which can be identified by having a load sharing control on the rear panel.

1. With power "OFF" and no-load connected, interconnect the two units as indicated in Fig i, with links on rear barrier strips as shown.

2. Set output voltage control of "SLAVE" unit fully clockwise.

3. Set output voltage control of "MASTER" unit mid range.

4. Set current limit controls of both units fully clockwise.

5. Set "LOAD SHARE" adjust controls (rear panel) fully clockwise.

6. Turn AC breakers "ON".

7. Set "MASTER" output voltage control to desired output voltage.

8. Turn AC breakers "OFF" and connect a load of between 60-80% of rated parallel current.

9. Turn AC breakers "ON". Unequal current readings may be indicated on the ammeters.

10. Rotate rear panel "LOAD SHARE" adjust control of the supply that indicates the "lesser" amount of current counter clockwise, while monitoring the ammeters, until both ammeters indicate a balance or equal reading.

11. Increase load to 100% of rated parallel current and recheck ammeter balance. If unbalanced, readjust the same "LOAD SHARE" control of step 10 above.

    The auto-parallel set-up is now complete with equal balance of load sharing.

Special Notes and Comments

WARNING:

The output voltage control of the "SLAVE" unit, which was rotated fully clockwise, should not be turned counter clockwise since turning below the output setting of the "MASTER" unit may cause damage to the supplies.

The diagram of Fig i shows connections for local sensing. If remote sensing is desired, it is only necessary to remote sense the leads of the "MASTER" unit.

At current drains below 60%, the balance may be off by as much as 5 Amperes, which is normal.

SECTION 1

DESCRIPTION

1.1 INTRODUCTION

The CR INTERMEDIATE REGULATION power supplies are flexible and dependable sources of D.C. power, which can be used to meet a variety of needs. These needs may range in scope from inspection and production testing, to laboratory bench testing and systems applications.

The wide range of outputs available makes these units well suited for use as basic laboratory power sources. The ability to provide power packaged in minimum space with high reliability meets the demands of most systems requirements.

All components used in the construction of the CR INTERMEDIATE REGULATION units are of the highest quality available, and have been subjected to 100% incoming inspection.

Each electrolytic filter capacitor is of computer grade, and has been quoted by the manufacturer as having a life expectancy exceeding ten (10) years. All silicon transistors have been "derated" and temperature aged to provide high reliability. All rectifiers are hermetically sealed silicon units, and all zener diodes have been temperature stabilized.

1.2 GENERAL FEATURES

Output, Sensing and Remote Programming terminals are located on a terminal board mounted on the rear paned of the unit. The AC power switch, AC pilot lamps, current and voltage controls and appropriate metering devices are all located on the front panel.

Constant Voltage Mode

A constant voltage is maintained across the output terminals at any preset value from zero to rated voltage output, provided that the load does not draw more than either the rated output current or more than the preset limiting current value determined by the front panel current control settings.

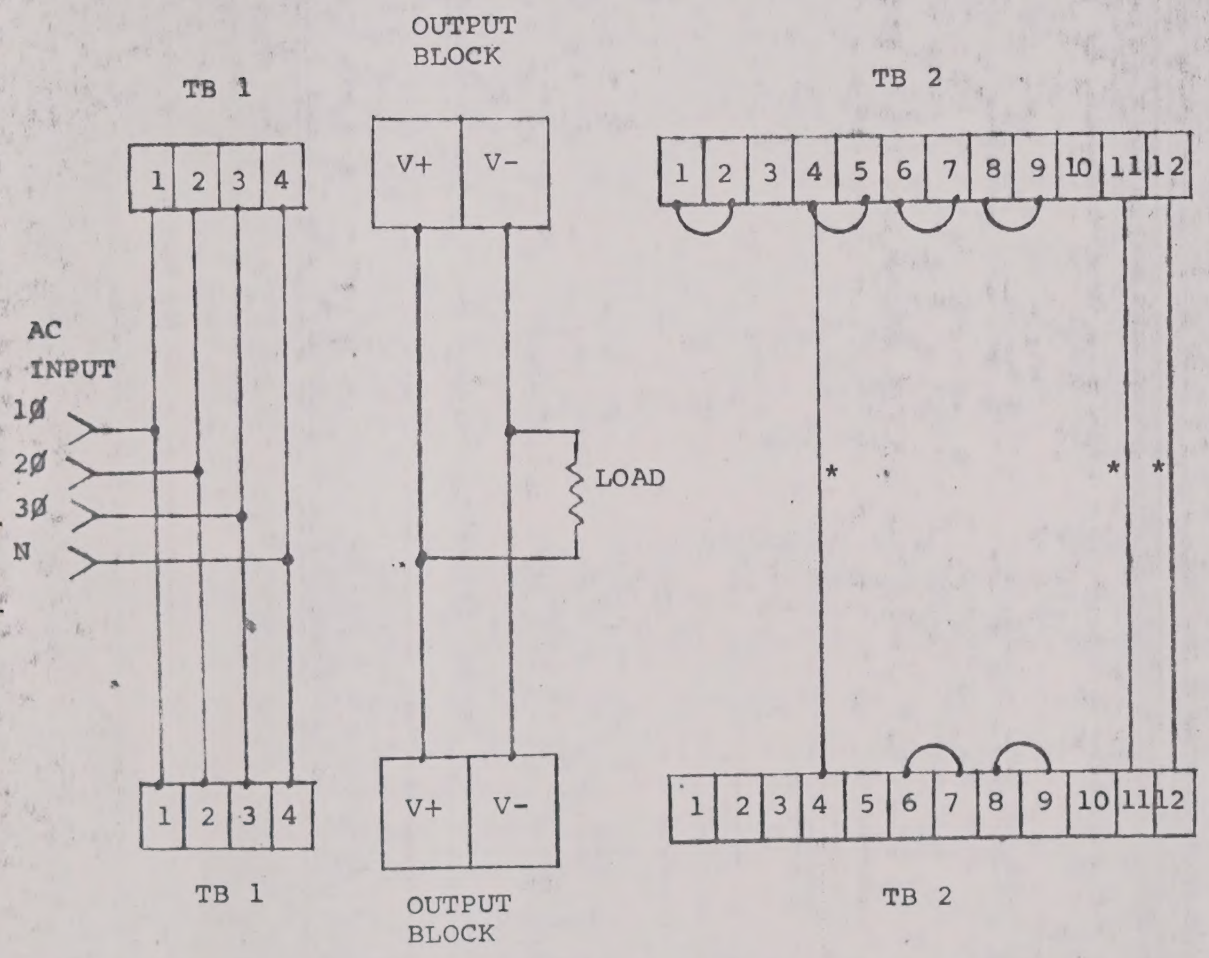
Constant Current Mode

Constant current operation is achieved by maintaining a constant voltage across an internal current sensing resistor. An automatic crossover network changes the mode of operation from Constant Voltage to Constant Current when the current demand reaches that of the preset current adjust control. The point at which the operating mode automatically changes is a function of variations in load conditions. The crossover point is adjustable, and can be established anywhere within the current and voltage range of the unit.

CR Series

AUTO-PARALLEL LOAD-SHARE HOOK-UP

MASTER UNIT



SLAVE UNIT

* Use #18-AWG or larger wire size

Fig. i

3/9/71

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SECTION 1

DESCRIPTION

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Each electrolytic filter capacitor is of computer grade, and has been quoted by the manufacturer as having a life expectancy exceeding ten (10) years. All silicon transistors have been "derated" and temperature aged to provide high reliability. All rectifiers are hermetically sealed silicon units, and all zener diodes have been temperature stabilized.

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Constant current operation is achieved by maintaining a constant voltage across an internal current sensing resistor. An automatic crossover network changes the mode of operation from Constant Voltage to Constant Current when the current demand reaches that of the preset current adjust control. The point at which the operating mode automatically changes is a function of variations in load conditions. The crossover point is adjustable, and can be established anywhere within the current and voltage range of the unit.

Automatic Current Limiting

Short circuit protection is provided by the Automatic Current Limiting circuit which limits the maximum output current under all load conditions. The point at which automatic current limiting occurs is variable, and may be selected anywhere between 5% of the rated current output and maximum rated current output of the unit. In the event of a short circuit, the output voltage will drop to zero, and will return to its previous level only upon removal of the short circuit.

Automatic Overvoltage Protection (Optional Feature)

Automatic Overvoltage (OV) protection prevents the output voltage from exceeding approximately 10% or 1.5 volts above the programmed voltage. An internal sensitivity control is provided to desensitize the overvoltage protection circuit.

Remote Programming

Remote Programming is provided in the voltage mode of operation, and may be utilized over the entire voltage range of the unit. The scale factor for Remote Voltage Programming is 100 ohms per volt.

1.3 PRECAUTIONARY MEASURES

Wire Size

To assure proper regulation under all load conditions, and to prevent severe distortions of the AC line voltage, it is very important to take into consideration the physical size and current handling capabilities of the input power line. Serious losses in regulation and an increase in ripple may result from underrated or overloaded AC input lines. The maximum AC impedance from the breaker box to the power supply input should not exceed 0.2 ohms.

Voltage Regulator and Inverter Inputs

Do not use voltage regulators or inverters as a primary power source. The outputs of these devices are usually not sinusoidal in nature, and if used as the AC source for the power supply, will cause serious loss of ragulation of the power supply output.

Systems Considerations

In systems applications it is recommended that each power supply input power line be run separately to the AC distribution box, in order to minimize cross coupling and interaction between equipment. Do not run sensitize signal leads such as the remote sensing leads in the same cable as the AC input without shielding. To keep the AC ripple in the output to a minimum, it is recommended that the AC input cables should not be run in close proximity to the output load cables.

Terminal Post Resistance

All terminals and shorting links serving Outputs, Sensing and Programming must be securely tightened before use. Serious loss of regulation and an increase in ripple can result due to a voltage drop caused by loose terminals and shorting links.

SECTION 2

INSTALLATION AND OPERATION

2.1 MECHANICAL INSTALLATION

2.1.1 Rack Mounting

Any standard EIA relay rack will accommodate the Trygon Intermediate Regulation Series power supplies in only 12 1/4 inches of vertical mounting space. Mounting of the unit is easily accomplished by inserting eight mounting screws through the slotted holes provided in the front panel of the power supply, and on into the matching threaded holes of the relay rack.

2.1.2 Bench Use

Though designed primarily as a rack mounting unit, the Intermediate Regulation Series power supply may be operated in a bench type configuration as well. It is therefore fully enclosed in a protective metal case.

2.2 INPUT, POWER

Standard "CR" supplies require a 3Ø, 4 wire input of 208 volts ±10% line-to-line. When delivering maximum rated power, the supply will draw approximately 20 amperes per phase. Input power connections are made via the four terminal Jones strip (TB1) located on the rear of the supply. Note that the terminal marking A, B, and C are arbitrary phase markings; and that any sequence of line connections will work satisfactory.

Caution: TERMINAL "N" is to be connected to the power line neutral only.

The power handling ability of the AC power lines must be considered, as serious losses in regulation and substantial increases in ripple can occur as a result of insufficient power handling capacity of these lines. The AC impedance from the breaker box to the power supply input connector should not exceed 0.2 ohms. All AC power line connections must be securely tightened, and any movable electric contact surface (such as the wiper arm of a variable transformer) should be kept clear of impedance producing oxide coatings.

Care should be exercised in selecting the proper wire size for the AC input lines. The figures listed in Table 2-1 will serve as a guide in making this selection.

TABLE 2-1 AC INPUT WIRE SIZE	
Length of Run (Single Lead)	Wire Size (AWG Standards
10 feet or less	10
10 feet to 20 feet	8
20 feet to 50 feet	6
50 feet to 100 feet	4

2.3 OUTPUT, REAR PANEL

A twelve terminal barrier strip (TB2) mounted on the rear panel provides sensing, programming, ground connections and provisions for paralleling. BARRIER STRIP terminal connections marked -V and +V have been provided as convenience TERMINALS only and ARE NOT TO BE USED FOR THE PURPOSE OF CONNECTING THE UNIT TO THE LOAD.

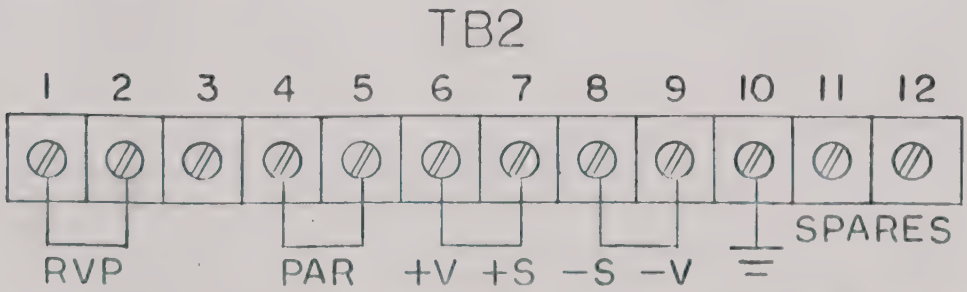
Shorting Link Application, Rear Panel

The power supply is shipped from the factory with shorting links in place across terminals 1 and 2, 4 and 5, 6 and 7, and 8 and 9 of the rear panel barrier strip. In this configuration, and with the load connected across the rear panel output terminals, local sensing and programming operation from the rear panel is provided.

Additional operating configurations may easily be achieved by changing shorting link connections or adding external wiring and controls, as outlined in TABLE 2-2 SHORTING LINK APPLICATION, REAR PANEL. Any one of the four combinations of functions may be used in conjunction with the CONSTANT VOLTAGE mode of operation.

FIGURE 2-1 REAR TERMINAL STRIP TB-2

Shorting Links



* Terminals 11 and 12 are used for remote current programming, only if this option incorporated. A shorting link is required across terminals 11 and 12 only if this option is incorporated but is not being utilized.

TABLE 2-2 SHORTING LINK APPLICATION, REAR PANEL		
SELECTION	FUNCTION	CONNECTIONS REQUIRED
1	Local Sensing Local Programming	1 and 2; 6 and 7 8 and 9; 4 and 5
2	Local Sensing Remote Programming	4 and 5; 8 and 9 6 and 7; PGM resistor across 1 and 2
3	Remote Sensing Local Programming	4 and 5 * 6 connected at load (+) 8 connected at load (-) 1 and 2
4	Remote Sensing Remote Programming	4 and 5 * 6 connected at load (+) 8 connected at load (-) 2 and 3; PGM resistor across 1 and 2

NOTE: The shorting link between terminals 4 and 5 must be connected for all modes of operation, except when AUTO-PARALLELING IDENTICAL SUPPLIES.

* The load must be connected to the terminals on TB3.

2.4 CONTROLS

Front Panel

TABLE 2-3 FRONT PANEL CONTROLS	
Name	Function
AC POWER	3Ø CIRCUIT BREAKER (CB1), controls input power
VOLTAGE ADJUST (Vernier)	Potentiometer, adjusts voltage output
VOLTAGE ADJUST (Coarse)	Potentiometer, adjusts voltage output
CURRENT ADJUST	Potentiometer, adjusts current

Internal

All internal control settings have been factory preset, and require no additional adjusting. However, if it should become necessary to adjust any of the internal controls due to circuit changes caused by component aging or replacement, refer to the calibration section of this instruction manual.

2.5 OPERATION

Control Settings

Set all front panel controls fully CW so that unit will operate in the Voltage rather than Current Limiting mode.

Shorting Links

If Local Sensing rather than Remote Sensing operation is desired, ascertain that shorting links are in place across the appropriate terminals.

Grounding

Either side of the Output may be grounded, or the Output may be used in a floating condition.

Power On

Connect the power supply to a nominal 3Ø 60 Hz. power source. Set circuit breaker CB1 to AC-ON, and observe that pilot lamps glow.

Warm-Up

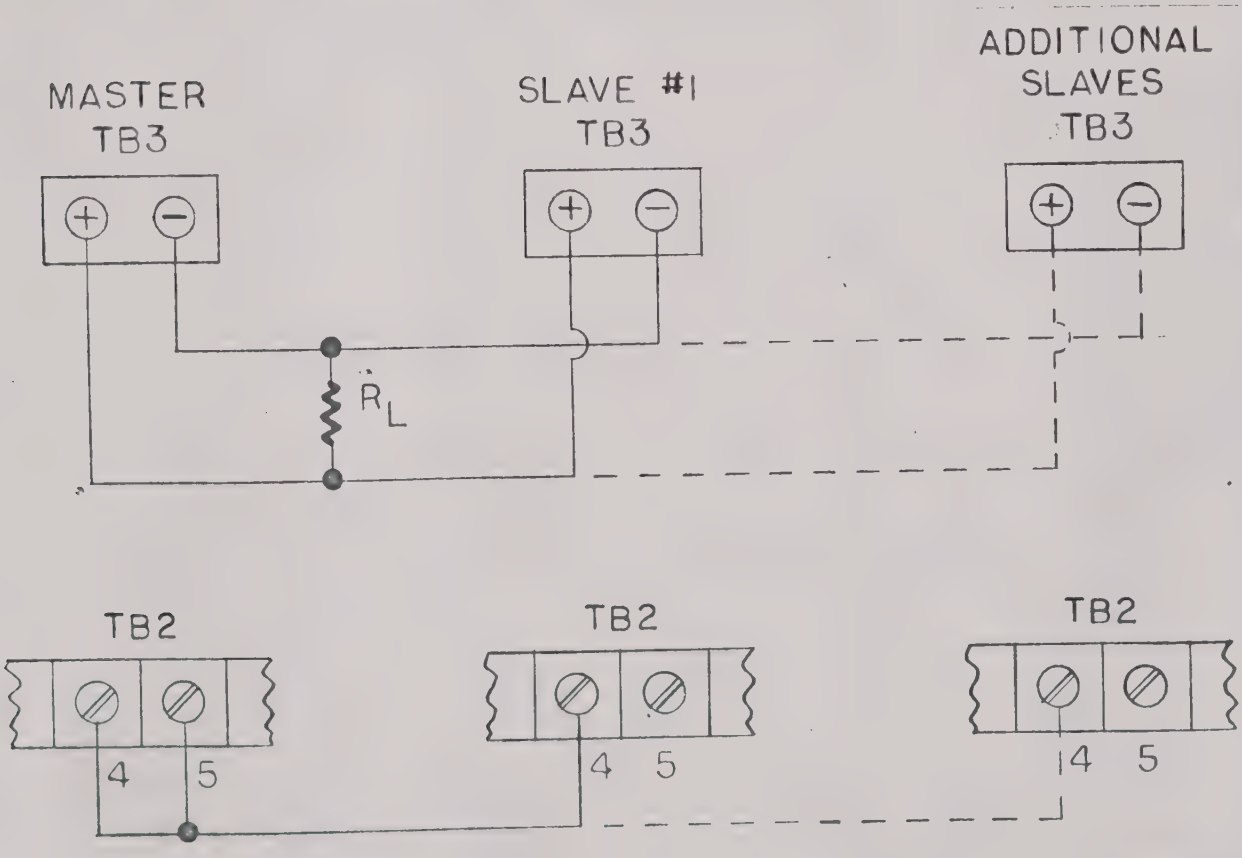
No warm-up time is necessary to place the unit into operation. However, a 30 minute warm-up period is recommended to reach rated stability.

2.6 AUTOMATIC LOAD SHARE PARALLELING (SEE ADDENDUM)

Set the front panel current limiting adjustment on each supply to its maximum setting and the "Master" voltage controls to the desired voltage.

Apply rated load and adjust the load sharing controls (R27) on the rear of each unit to achieve equal current contribution from each supply.

FIGURE 2-2 AUTOMATIC LOAD SHARE PARALLELING



NOTE: If parallel operation of CR INTERMEDIATE REGULATION power supplies utilizing Overvoltage Protection (O.V.) is desired, consult the factory for special instructions.

SECTION 3

THEORY OF OPERATION

3.1 POSITIVE AUXILIARY SUPPLY

The Positive Auxiliary Supply provides an unregulated DC voltage of low ripple content to feed the power supply reference and forward bias the zener diode (CR29) in the constant current bleed circuit. Approximately 32 volts will be established across C6 at nominal input voltage. This voltage is obtained via 3 phase full wave rectification from the secondaries of transformers T2, T3 and T4. The following diodes are utilized in developing the 32 volt potential across C6: CR65, CR60, CR59, CR54, CR53 and CR48.

3.2 NEGATIVE AUXILIARY SUPPLY

The Negative Auxiliary Supply provides an unregulated DC voltage of low ripple content to feed zener diode CR11 in the constant current reference supply. Approximately 32 volts will be established across C22 at nominal input voltage. This voltage is obtained via 3 phase full wave rectification from the same transformers used to develop the positive auxiliary voltage. The following diodes are used to develop this voltage: CR64, CR61, CR58, CR55, CR52 and CR49.

3.3 VOLTAGE REFERENCE

The Voltage Reference develops a highly stable precision DC output of 15 volts, used to bias and supply voltage to the critical differential amplifiers. It must be emphasized that any ripple component, noise or lack of stability present on the output of the voltage reference will be amplified by the differential voltage comparator Q1 and Q2 and will be present to a larger degree at the power supply terminals.

The voltage reference is supplied from the positive auxiliary supply thru R33 and is clamped by zener diode CR11 at 24 volts. Zener diode CR10, a 5.1 volt zener diode establishes a 18.9 volts on the base of Q8 relative to the anode of CR11. THE ANODE OF CR11 OR THE "+S" SENSING TERMINAL, AN ELECTRICALLY IDENTICAL POINT, WILL BE USED AS A REFERENCE OR ZERO POINT FOR ALL VOLTAGE MEASUREMENTS, UNLESS OTHERWISE STATED. The emitter of Q8 will be .8 volts higher than its base placing 4.3 volts across R30. Q8 function as a current generator supplying 15 ma.

3.4 POWER CIRCUITRY

All CR Intermediate Regulation Series power supplies are designed for operation from a three phase power line and employ a three phase power transformer T1; the output of this transformer is fed into a three phase full wave bridge, consisting of three rectifiers, CR23, CR24 and CR25 and three silicon control rectifiers, CR20, CR21 and CR22. Output voltage control is obtained by delaying the firing angle of these SCR's to meet the demands placed on the supply.

The output of this bridge is fed into an iron core inductor, L1, and capacitors C13 thru C17 for filtering.

3.5 PHASE SEQUENCING DETECTOR

The Phase Sequencing Detector permits all CR Series power supplies to be connected to the appropriate 3 phase power line without the need to determine the direction of phase rotation prior to making power line connections. The phase detector consists of a special unbalanced 3 phase load; R64, R65 and C18. The voltage developed across R65 is fed into a full wave bridge (CR32, CR33, CR34 and CR35) and rectified output is used to control the coil on relay K1. If the power line phase sequence was such that proper operation of the supply would exist with relay K1 in the de-energized state, relay K1 would have only 6 volts on its 24 volt coil. However if the phase were incorrect, 24 volts would be applied to the coil of K1 causing it to energize and its contact switching would automatically correct the phase sequencing of the SCR gate signals.

3.6 MISSING PHASE DETECTORS

In the event one phase of the input power line is lost the "Missing Phase Detector" will shut down the power supply. This condition may confirmed by observing that one or more of the front panel lamps are not illuminated. Operation of the missing phase detector follow: The secondary of each auxiliary transformer will produce a DC voltage across a separate capacitor, only when voltage on the phase feeding that particular transformer is present. Diodes CR62 and CR63 will charge up C21; diodes CR57 and CR56 will charge up C20 and diodes CR51 and CR50 will charge up C19. When 3 phase line voltage is present, these capacitors, C19, C20 and C21 will be charged up to about 28 volts, reverse biasing the "Missing Phase Gate Diodes" CR45, CR46 and CR47. Under these conditions transistor Q20 will conduct, since base current is provided from the positive auxiliary voltage, thru R88, CR28 and R75. If one phase of the input power line were lost, on the base of zener diode CR28 such that transistor Q19 from supplying pulses to the silicon control rectifiers.

3.7 GATING CIRCUITRY

The Gating Circuitry provides to each silicon control rectifier a pulse of the proper amplitude and timing to allow the power supply to meet the output demands made upon it.

The emitter of unijunction transistor Q19 is fed from the collector of Q7 and will produce a pulse across the base 1 resistor, R68, when ever additional input voltage is required. This pulse is amplified by transistors Q20 and Q22, providing a pulse of approximately 20 volts amplitude on the collectors of Q22, Q16, Q17 and Q18. The pulse is distributed to the base of the SCR by transistors Q16, Q17 and Q18, dependent on the bias on their respective bases. The base of each of these transistors are fed these resistors connects to two diodes. These diodes function as OR gates. For example, transistor Q16 will distribute the pulse feed to its collector, to an SCR only when OR gate diodes CR41 and CR42 are both reversed biased.

The cathode of the OR gate diodes CR39 thru CR44 each connect to a different transformer lead which provides the proper signal for each respective gate. The anodes of each OR gate connect via a fixed resistor, an adjustable resistor and a diode to the base of transistor R74. These variable resistors, R78, R81 and R86 are adjusted to provide a balanced ripple output (viewed on an oscilloscope) when the supply is delivering approximately 15% of rated output voltage at full rated current. The voltage applied to the base Q74, a rectangular type wave form of high duty cycle, will turn transistor Q24 on and off at a rate of 180 Hz or three times power line frequency. Q24 supplies the drive for Q23, turning it on and off at the same rate. The voltage developed on the collector of Q23 is fed thru resistor R71 where it is clamped by a 5.1 volt zener CR27. This voltage, a rectangular wave form of very high duty cycle, is fed to base 2 of the unijunction transistor. It is this wave form that synchronizes the unijunction transistor to the power line frequency.

3.8 CONSTANT CURRENT BLEED

The Constant Current Bleed permits the output DC voltage to be rapidly reduced by providing a load to discharge the input capacitors C13 thru C17. The bleed is made up of three power transistors (Q13, Q14 and Q15) in parallel, with Q12 used as a driver. Zener diode CR29 is forward biased by 8 volts via the positive auxiliary voltage and R59. The voltage on the base of the driver Q12 with reference to the negative output voltage is clamped to 1.5 volts by series combination of diodes CR17, CR18 and CR19. At high output voltages, the voltage developed across R52, R56 and R57 due to the current flowing thru R53, R54 and R55 respectively will produce a voltage sufficient to reverse bias and cut off all four transistors. As the output voltage is decreased these transistors will began to conduct and the total current drawn will remain approximately 10% of the rated current of the power supply.

3.9 CURRENT MODE INDICATOR

The Current Mode Indicator circuit is responsible for illuminating the front panel current mode light whenever the power supply is functioning in the constant current mode of operation.

The circuit consists of four transistors, Q3, Q4, Q5 and Q6. The mode indicator lamp is connected between a 24 volt source and the collector of Q5. Q4 and Q5 form a differential amplifier used to improve the sharpness of transition from the "on" to "off" state. Transistors Q4 and Q5 are driven by transistors Q3 and Q6 respectively. The base of Q6 connects to the anode of "OR" gate diode CR7 and also senses the collector current drawn by Q10, the current differential. Likewise, transistor Q3 connects to the anode of "OR" gate diode CR6, and also senses the current drawn by transistor Q1 of the voltage differential.

3.10 VOLTAGE COMPARATOR

The Voltage Comparator is a differential amplifier that "compares" a portion of the output voltage to a calibrated voltage and produce an error signal used to correct for any unbalance in these voltages.

This error signal is fed to the base of transistor Q7 via "OR" gate diode CR6 only when the supply is functioning in the constant voltage mode.

The operation of the voltage comparator is as follows, (refer to Fig. 3-1);

The base of transistor Q2 is at 7.5 volts due to the voltage divider consisting of R17 and R18. In the voltage mode, the voltage comparator is a balanced differential therefore, the voltage on the base of Q1 is also 7.5 volts. Since the base current of the differential is very small, 7.5 volts is placed across the series combination of R1 and R2. This voltage will force a constant current of approximately 10 ma to flow through the series combination of R1, R2, R3, R4, R49 and R50. Resistors R3 and R4 are selected to provide zero output when R49 and R50 are set to minimum resistance. The output voltage range is determined by R49 and R50 and is approximately 1 volt for every 100Ω's of resistance. The collector of Q1 is connected to the base of Q7 via "OR" gate diode CR6. CR6 will be forward biased whenever the power supply is functioning in the constant voltage mode of operation.

3.11 CURRENT COMPARATOR

The Current Comparator is a differential amplifier that "compares" a voltage proportional to the output current with a calibrated voltage and produces an error signal used to correct for any difference in these voltage levels. This error signal is fed to the base of transistor Q7 via "OR" gate diode CR7 only when the supply is functioning in the constant current mode.

The operation of the current comparator is as follows, (refer to Fig. 3-2);

The "+V" Sensing Terminal will be used as a reference or zero point for all voltage measurements unless otherwise stated.

The base of transistor Q10 is connected via R36 to the "+V" output terminal. Since the base current of transistor Q10 is very small (10-50 ma), the voltage drop across R36 is negligible, and the base is at zero potential. Resistors R34 and R35 and zener diodes CR12 and CR13 form a cascade zener diode voltage regulator resulting in a 5.1 volt potential across capacitor C7.

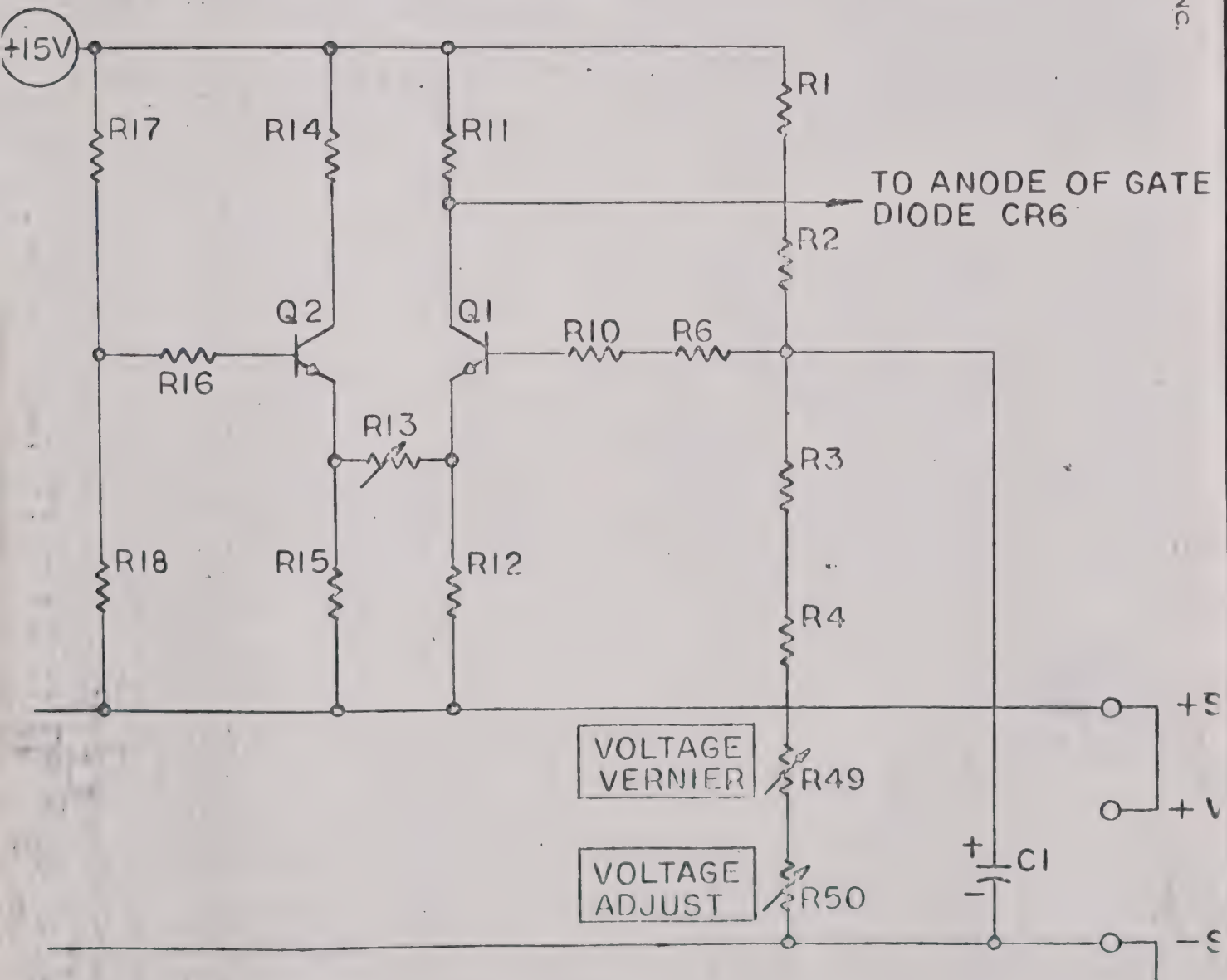
The emitter of transistor Q10 will be about .7 volts negative due to the base to emitter drop. The resulting voltage across the parallel combination of R38 and R40 will demand approximately 1.8 ma from the 15 volt source.

The base of transistor Q11 is connected via resistors R43 and R46 to a tap on a voltage divide consisting of the front panel current adjustment control R60 on one side of the divide and the internal maximum current adjustment R48 in series with R47 on the other side of the divide.

R48 is adjusted to provide a maximum output current of 110% of rated current when the front panel current adjustment control is set for maximum current. One end of the current adjustment control, R60 is common to one end of the current sensing resistor R51, and as a result a voltage proportional to the load current is applied to R60.

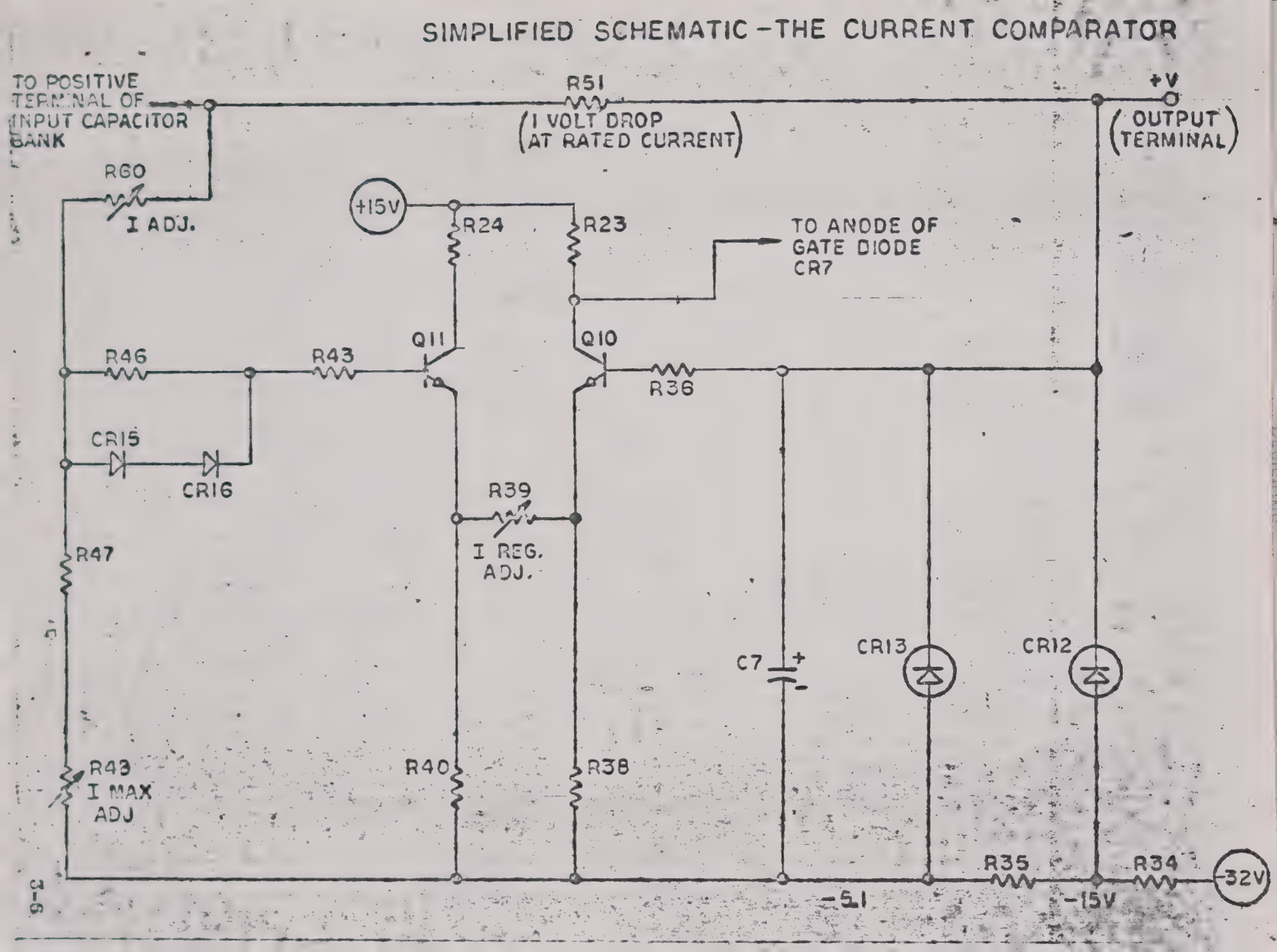
Whenever the power supply is operating in the constant current mode transistor Q11 will forward biased causing the collector voltage on Q10 to rise. This rise in voltage is fed via "OR" gate diode CR7 to the base of Q7.

FIGURE 3-1 *SIMPLIFIED SCHEMATIC- THE VOLTAGE COMPARATOR



*IN THE INTEREST OF CLARITY SOME COMPONENTS HAVE NOT BEEN SHOWN.

SIMPLIFIED SCHEMATIC – THE CURRENT COMPARATOR



SECTION 4

MAINTENANCE

4.1 GENERAL

This power supply is a precision instrument. It is strongly recommended that only experienced troubleshooting personnel perform troubleshooting operations or attempt to repair the unit. If the power supply appears to be malfunctioning at all, the following procedure is recommended for isolating possible defects.

4.2 LOADS AND INTERCONNECTIONS

1) Disconnect all loads and interconnections.

2) Connect a resistive load across the output terminals, and operate the unit to determine whether the fault lies within the unit or externally. Observe that Shorting Links are in place across terminals 1 and 2, 4 and 5, 6 and 7, and 8 and 9, and that all connections are tightly made.

4.3 TROUBLESHOOTING

1) Set VOLTAGE ADJUST control R49 and VOLTAGE VERNIER control R50 fully CW. Use a 20,000Ω's per volt voltmeter or oscilliscope to check the voltages across the various circuit components listed in the Troubleshooting tables of this section. Any reading which is grossly incorrect indicates that the stage being tested or the one preceding it, is defective. The Block Diagram, Schematic Diagram, Component Board Drawings and appropriate sections of the Theory of Operation will prove very helpful in any troubleshooting work. Proper polarity to be observed when testing can be easily obtained from the Schematic Diagram.

2) If voltage checks show no noticeable deviations from the prescribed values, disconnect AC power and proceed with point to point resistance checks across pots, switches, diodes, resistors, transistors in that order.

3) When the trouble is of an intermittent nature such as poor regulation, ripple etc., the use of an oscilloscope to determine dynamic changes will be necessary. The section on Theory of Operation should be consulted to determine circuit performance with varying output conditions.

4.3.1 REFERENCE SUPPLY

TABLE 4-1 REFERENCE SUPPLY	
Measured Across Component	DC Voltage Reading ±10%
R31	15*
CR11	24
CR10	5.1
CR66	6.5
CR9	9.3

* If this voltage is in tolerance, check the line regulation (±10% from nominal line) and noise level across R31. A line regulation of 10 mv or less and a noise level of 1 mv or less indicates the reference supply is operating satisfactory, and additional voltage checks in this circuit are not required.

TABLE 4-2 PRIMARY VOLTAGES		
Measured Across Component	DC Voltage Reading ±10%	If Out Of Tolerance Refer to Theory of Operation.
C6	32	Positive Aux. Sup.
C22	32	Positive Aux. Sup.

TABLE 4-3 VOLTAGE COMPARATOR VOLTAGES		
Measured from "S" to;	DC Voltage Reading ±10%	NOTE
Base of Q2	7.5	If out of Tolerance refer to Theory of Operation.
Base of Q1	7.5	
Collector of Q1	9.0	

SECTION 5

CALIBRATION

5.1 GENERAL

The following adjustments should be made when necessary to assure optimum operating characteristics and maximum efficiency of the series power supplies.

5.2 TEST EQUIPMENT REQUIRED (or equivalent)

1) Differential VTVM, Fluke Model 825A
2) AC VTVM, Hewlett Packard Model 400D
3) Oscilloscope, Tektronix Model 561
4) Variable Auto transformer, 3 phase type with 20 amp minimum rating
5) Standard Ammeter-Full scale at least 120% of rated supply current

Shorting Link Application

For test purposes shorting links should be connected across rear panel barrier strip terminals 3 and 4, 6 and 7, 8 and 9 and 11 and 12 to provide local sensing and local voltage programming operation. To reduce pickup, shielded wire must be used for all connections between test equipment and the power supply being tested. To prevent ground connection be made, as shown in Fig. 5-1. Tighten all terminals as securely as possible and set all front panel controls CW.

5.3 CALIBRATION PROCEDURE

Current Limit

1) Set the front panel current adjustment control R60 to its maximum setting (fully CW).
2) Set the front panel voltage adjustment controls to provide rated output voltage.
3) Apply an external load to the output terminals and adjust the load resistance for a maximum current of 120% of the rated current. It may be necessary to adjust R48, the internal current adjustment pot, to reach the specified current.
4) Using a standard ammeter in series with the external load, adjust R48 to obtain a current reading of 1.05 to 1.15 rated current as observed on the standard meter.

Ammeter Adjustment

1) Using a standard ammeter in series with an external load, adjust the output voltage and load resistance to provide exactly rated current as observed on the standard ammeter.

Constant Voltage Operation

Load Regulation

With the equipment connected as shown in Fig. 5-1, connect a suitable load resistance across the output terminal connections. The load resistance selected must be able to dissipate the rated power of the unit (P=IE) and must be of sufficient value to yield the rated output current when the rated voltage is applied. Note the voltage indicated on the Differential VTVM. Disconnect the resistive load from the output. If the change in output DC voltage is more than .1% + 5 mv of the output voltage, adjust the Voltage Regulator Adjustment R13 to meet or improve the regulation specification. This adjustment should be made while alternately switching the load on and off.

Line and Load Regulation

Using the equipment as shown Fig. 5-1, place the same load resistance as previously used for load Regulation Measurement across the output terminals, and note the Differential VTVM indication. Vary the AC input voltage 10% above and below the nominal AC input level and record the maximum and minimum output voltages. Remove the load resistance and, again, vary the AC input voltage 10% above and below the nominal AC level and record the minimum and maximum output voltages. The calculated combined line and load regulation should be less than the specification, 0.2% + 10 mv. If this regulation can not be met, repeat the procedure for adjustment of load regulation.

Ripple Voltage

In order to reduce pickup, shielded test leads should be used in making ripple measurements. With the resistive load connected across the output terminals, measure the AC ripple with the AC VTVM. Vary the AC input power 10% above and below the nominal AC input level. The maximum ripple amplitude should not exceed the value specified on the data sheet for the model under test.

Constant Current Operation

Load Regulation

With the equipment connected as shown in Fig. i _, and with nominal AC input voltage, adjust the output voltage to its rated value. Apply a resistive load to the output terminals and adjust both the load resistance and the front panel current adjustment pot until the power supply is delivering rated power into the load and is operating in the constant current mode, as indicated by illumination of the mode indicator lamp.

Record the reading on the differential VTVM and close the shorting deivce (see Fig. 5-2). Adjust the current regulator adjustment R39, while alternately shorting out the load resistance, to obtain the best possible load regulation.

Line and Load Regulation

With the equipment connected as shown in Fig. 5-2, and with nominal AC input, adjust the power supply to deliver rated power into the load while operating in the constant current mode. Vary the AC input voltage 10% above and below the nominal AC input and record the maximum and minimum output voltages. Close the shorting device and repeat the voltage measurements as the line voltage is, again, varied 10% above and below the nominal AC input level. The calculated combined line and load regulation should be less than 1% I_{rated} or 1 amp, whichever is greater.

Phase Balance Controls

With the equipment connected as shown in Fig. 5-1, and with nominal input voltage, set the output voltage to approximately 1/6 of maximum voltage. Connect a suitable load resistance to the output terminals of the power supply such that rated current will flow. Adjust the Phase Balance Controls, R86, R81, R78, to establish a symmetrical ripple waveform as observed on the oscilloscope.

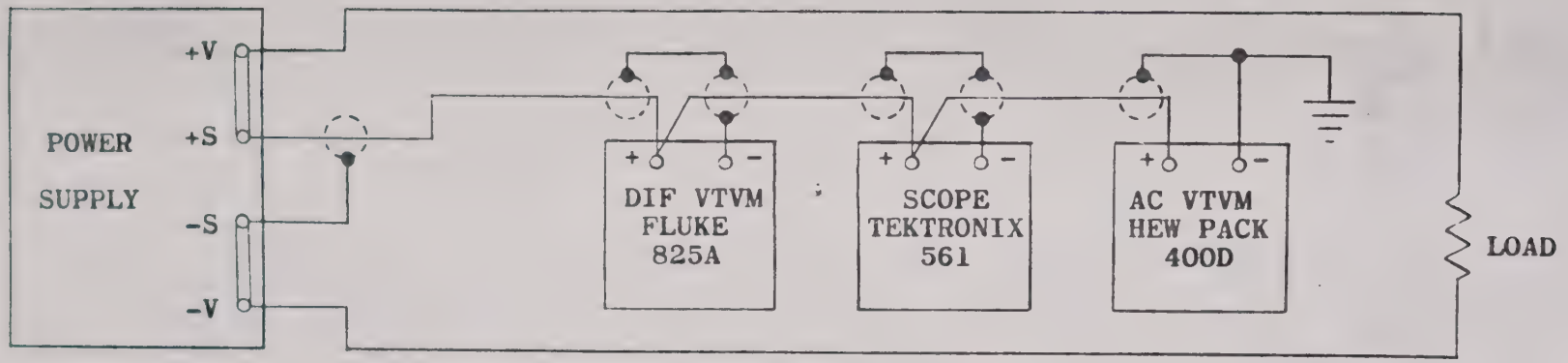


FIGURE 5-1
CONSTANT VOLTAGE OPERATION

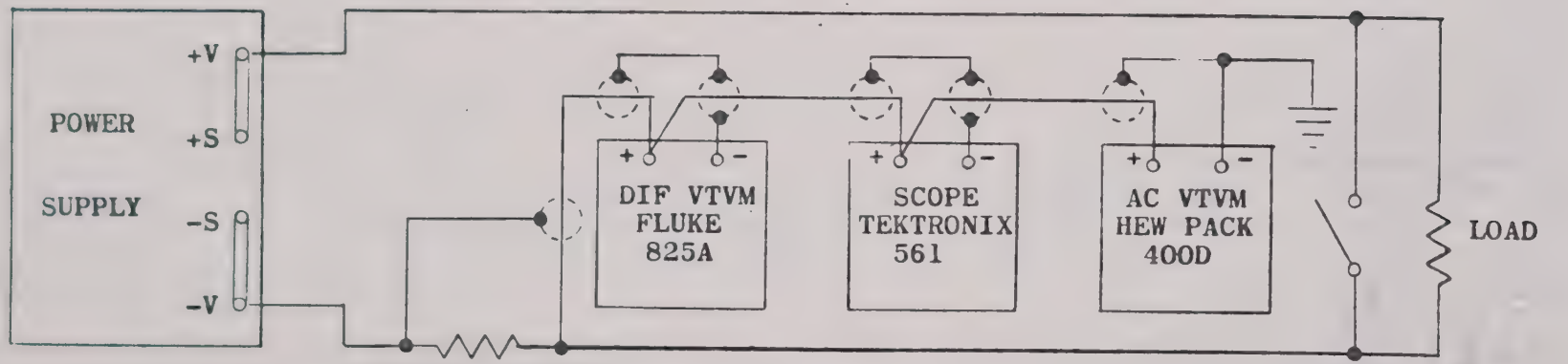


FIGURE 5-2
CONSTANT CURRENT OPERATION

TRYGON
ELECTRONICS INC.

Semi-conductors commonly used in Trygon power supplies are available for replacement or spare parts use under the following Trygon, commercial manufacturer or JEDEC part number

TRANSISTORS

SEMI-CONDUCTOR PART NUMBERS

TRYGON STOCK NO.	TRYGON or MFR P/N	JEDEC EQUIVALENT
700000	See 705067	
700001	See 700002	
700002	700002	2N3638A
700010	TR346	2N1556
700020	See 705067	
700030	TR361	2N652
700040	TR375	2N1533
700047	700047	2N4238
700050	700050	2N657A
700070	TR951	2N2527
700080	700080	2N3055
700083	700083	2N3232
700085	700085	2N3442
700115	See 705067	
700120	700120	2N1530
700130	700130	2N1554
700140	700140	2N1560
700160	700160	2N2140
700180	700180	2N2714
700182	700182	2N3566
700191	700191	2N4912
700195	700195	2N3441
700196	700196	2N4912
700197	700197	2N3738
700200	700200	2N2139
700205	700205	2N3440
700400	700400	2N3441
700401	700401	2N3771
700402	700402	2N3772
700410	700410	2N3442
700412	700412	2N3568
700413	700413	2N3644
700415	700415	2N3585
700417	700417	2N4918
700420	700420	2N3584
700429	DTS411	DTS411
700430	DTS413	DTS413
700431	DTS423	DTS423
700502	700502	2N5037
700508	700508	2N5240
705018	705018	2N3416
705067	705067	2N2905A
705068	705068	2N2219A
705069	705069	2N4340
705070	705070	2N3233
705071	705071	2N3447
720145	UJ25	2N2647

Semi-conductors commonly used in Trygon power supplies are available for replacement of spare parts use under the following Trygon, commercial manufacturer or JEDEC part number

RECTIFIERS

S E M I - C O N D U C T O R P A R T N U M B E R S

TRYGON STOCK NO.	TRYGON or MFR P/N	JEDEC EQUILVALENT
705014	705014	2N1929
720000	C35B	2N685
720005	C33F	
720010	C35F	2N682
720015	C30F	
720030	C50AX258	
720040	C50B	2N1913
720043	C50C	2N1915
720050	C50F	2N1910
720053	C60A	2N2025
720060	E016	
720075	E0130	
720110	SV515	1N823
720131	720131	1N3618
720132	720132	1N3616
720133	720133	1N3619
720135	720135	1N3495R
720136	720136	1N3621
720137	720137	1N3622
720173	1N759A	1N5242B
720175	1N746A	1N5226B
720181	1N751A	1N5231B
720182	1N754A	1N5235B
720185	1N752A	1N5232B
720192	1N753A	1N5234B
720196	1N755A	1N5236B
720241	1N1360A	1N2986A
720262	1N2163A	1N2163A
720263	1N2163A	1N2163A
720273	SCR285-2	
720274	SCR285-3	
720275	SCR285-4	
720277	SCR285-5	
720280	SCR93-2	
720290	SCR93-3	2N2573
720300	SCR93-4	2N2574
720301	SCR93-5	2N2677
720303	SCR93-7	
720330	70H10	
720335	40HF10	1N1184A
720350	70H20	1N4136
720383	1N4585	1N4585
720384	1N4384	1N4384
720387	1N4740A	1N4740A
720388	1N4733A	1N4733A
720394	1N964B	1N5243B
720395	1N965B	1N5245B

Semi-conductors commonly used in Trygon power supplies are available for replacement of spare parts use under the following Trygon, commercial manufacturer or JEDEC part number

RECTIFIERS

S E M I - C O N D U C T O R P A R T N U M B E R S

TRYGON STOCK NO.	TRYGON or MFR P/N	JEDEC EQUILVALENT
720427	See 720136	
720440	TR4148	1N4148
720443		1N3208
720450	See 720456	1N3659
720453	See 720456	1N4719
720454	MR1031A	1N4720
720455	MR1032A	1N4721
720456	MR1034A	1N4722
720458	See 720456	
720459	1N758	1N758
720397	1N2164A	1N2164A
720460	1N961B	1N5240B
720468	1N968	1N5250B
720473	1N821	1N821
720488	60HF60	1N2138
720489	C46E	
725008	C180A	
725019	1N765A	1N5241B
725056	MR1220SL	
725071	1N3515A	1N5236B
725076	1N3616	1N3616
725077		1N3262R
725079	MCR2835-4	
725081	MCR216R-2	
725082	MCR216R-3	
725083	MCR216R-5	
725085	MCR216R-6	
725087	MCR3918-1	2N5168
725138	725138	2N4441
725139	See 725142	
725140	MAC 3-2	
725142	725142	2N4442
725143	Y0525	
725144	40526	
741001	741001	2N4990

ELECTRONICS INC.

ASSY TYPE ▶ CA36105 "01"

SCHEMATIC DWG NO _____ REV _____

FRONT PANEL DWG NO _____

CHASSIS DWG NO _____

TRYGON ELECTRONICS, INC.

LIST OF ELECTRICAL PARTS

LEP NUMBER

PROJECT # _____

REV _____

SHEET _____ OF _____

PROD BY _____ CKD. BY _____

DATE _____ APPD BY _____

LINE NO.	REFERENCE DESIGNATION	HI REL PSC NUMBER	DESCRIPTION	MFR	MFRS NO OR SPEC NO	TRYGON DWG. NO.	RECOMMENDED SPARES
1	C100		CAP 25MF 50V				810045
2							
3	CR105, 106, 107		DIODE	TRY	TR4148		720420
4	C102		"	TRW	IN751A		720187
5	CR103		THYRISTOR		MAC2-2		725140
6	CR104		DIODE		MR1221		725056
7	CR105		RECTIFIER SILICON CONTROL	GE	C20F		725000
8	CR106		DIODE ZENER	GI	1N4744		720147
9	Q101		TRANSISTOR	TRY	TR22		720045
10	Q102		"	"	TR2955		720115
11							
12	L2		CHOKE	TRY	501380		501380
13							
14	R100		ALES 3.01K .5w 1%	IRES	CEC1/2		610301
15	R101		680 .2w 5%	"	CC1/4		620681
16	R102		" 220 .5w 10%	AB	MC20S 221K		621221
17	R103		5.3K .5w 1%	"	"		611531
18	R105		11K .5w 10%	"	"		611103
19	R104		10K	"	"		611003
20	R106		1.5K 3w	BIS	TYPE 1		611502
21	R107		470 .5w 10%	SAUF	"		620471
22	R108		2.1K 10w 5%	RW	5		610145
23	R109		33 .5w 10%	MIL	RCR X4		611335
24				MIL	RC20		611021
25							
26							
27							
28							
29							
30							

REV LTR	DATE	BY	CKD	REVISION

REV LTR	DATE	BY	CKD	REVISION

REV LTR	DATE	BY	CKD	REVISION

SYM	ZONE	DESCRIPTION	DATE	APPD
H		SEE SHT 3 OF 3, ECN-3943	6-4-71	
J		DEL. SHT 3 OF 3 - 4294	6-11-71	
K		SEE SHT. 3 OF 3 - ECN 4918-4949	7-16-71	
L		R27 WAS 1N751 ECN 4701 R.C.	7-16-71	
M		SEE SHT. 2 OF 2 - ECN 5040	8-10-71	
N		DEL SHT 3 OF 3 - ECN 5015	8-19-71	
P		SHT 3 OF 3 - ECN 5118	9-7-71	
R		R15 WERE 10K IN CR110-30 SEE SHT OF TCMS 5760, 5146	10-4-71	
S		R27 WAS 10K IN CR65-85 - ECN 5212, 5317	10-26-71	
T		SHT 2 & 3 OF 3 - ECN 5228, 5235	11-3-71	

SYM	ZONE	DESCRIPTION	DATE	APPD
D		DELETED	2-27-68	P.R.
E		6V CKT SUIT, MODEL CR2/150 CR20 - CR22 WAS CC1A, E106 WAS 2.55R, 2W, ECN'S-3639, 3644, 3718	2-27-68	P.R.
F		SEE SHT 3 OF 3 - ECN-3546	3-28-68	P.R.
G		MODELS: CR20-150, CR20-150 6V, CR36-100, CR36-100 6V, CR65-85, CR65-85 6V, CR110-30, CR110-30 6V, R35 WAS 400, 3W, R47 WAS 340, 1%, MODEL CL5, C6 & CR7 - ECN'S-3865, 3866, 3867 & 3868	5-22-68	P.R.
		MODELS: CR36-100 & CR36-100 6V,		
A		ADD R & C WERE 10K, 1/4W; 1 WAS 750, 1%; R5 WAS 2.55K, 2W; R6 & R57 WERE 3.3K; C1 WAS 10µF, 15V; 14 - ET, ET, ET, 7 WERE 3.3K		
B		RCS		
C		SED PER ECN 3867		
		R7A & B WERE 10K; 7 [illegible] WERE 10K, MODELS R7, R8 WERE 10K; C2 WAS 10µF, 10V; TO C2 - SHT 2, (MODEL CR36-100 & CR36-100 6V), C12, C17 WERE 40µF, 150 WAS 5.6K (MODEL CR20-150), C12-C17 WERE 47µF, 20V; CR110-30, CR65-85, CR36-100 WERE ILLEGIBLE, MIL WAS		
		W1 3, CR20-150 WAS CR65-85, CR36-100 WAS CR65-85		

1. TO AMPLIFIER AND POWER CIRCUITRY.
3. TO AMPLIFIER
8. TO AMPLIFIER

PHASE BALANCE CONTROLS

NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTORS ARE 1/4 WATT, ALL CAPACITORS ARE IN MICROFARADS.
2. ALL DIODES ARE IN4384.
3. UNLESS OTHERWISE SPECIFIED, USE TABLE FOR VALUES.

CR110-30	4.7K	4.7K	4.7K
CR65-85	4.7K	4.7K	4.7K
CR36-100	10K	10K	10K
CR20-150	10K	10K	10K
MODEL	R76	R79	R83

LIST OF MATERIAL FOR ASSEMBLY

DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS DECIMALS ANGLES

TRYGON ELECTRONICS INC.
ROOSEVELT, NEW YORK

MODEL CR 36-100

SCHEMATIC
DIAGRAM

SIZE	DWG. NO.	REV
D	09206	R37

SCALE 2/1

		R5	R7	CR3
420-153	50V	1000	390	IN4384
	50V	1000	390	IN4384
	15 250V	22K	OMIT	OMIT
280-55	4 17.5V	1K	OMIT	OMIT

SYM	DESCRIPTION	DATE	APP
L	ECN 4418 - 4949	7-10-69	
M	ECO 4701	7-11-69	
N	ECO 4769	9-21-70	
Q	ECO UNIT 13 - ECN 5-8111-19-76	11-19-70	
R	ECO UNIT 143 - ECN 5-8120	2-16-71	
S	ECO UNITS 1-5 - ECN 8201	2-16-71	

SYM	ZONE	DESCRIPTION	DATE	APP
G		UPC SHT. 1 OF 8 - ECN 5-8645, 8866, 8867, 8868	10-15-71	RE
H		R50 WAS 4K, NOW CR36-100 CW 3 WAS 30 - ECN 8722	10-15-71	RE
J		SHT 3 OF 8 WAS UNIT 4 - ECN 8722	10-15-71	RE
K				

SYM	ZONE	DESCRIPTION	DATE	APP
A		REVISED PER ECN 8297	12-15-71	RE
B		25V TO 35 PER ECN 8297	12-15-71	RE
C		REV. PER ECN 8375 & 8376	3-6-72	RE
D		SHT 2 OF 8 REVISED PER ECN 8722	10-15-71	RE
E		SHT 2 OF 8 REVISED PER ECN 8722	10-15-71	RE

TO AMPLIFIER AND GATING CIRCUITRY

TO GATING CIRCUITRY

TO POWER CIRCUITRY

R33 50 10W

CR11 IN1360A

CR10 IN751A

R30 200 3W

C28 10 50V

Q8

CR8 IN749A

IN4148

R26 .402 1%

R43 8.25K 1%

Q7 TN1147

C8 100

C1 .5

R28 1.99K

R29 100K

C9 10 50V

R47 150 1-1/2W

CR15 CR14

C10 30 50V

R45 150

DR TO TRIAMP

TO GATING CIRCUITRY

TO GATING AND POWER CIRCUITRY

TO GATING CIRCUITRY

NOTE:

* 1. SELECT AT TEST.
2. UNLESS OTHERWISE SPECIFIED: ALL DIODES ARE IN4384.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES

TRYGON ELECTRONICS INC.

MODEL CR SERIES REGENERATIVE CONTROL AMPLIFIER

09206 D SHEET 2

	CR103	CR105	R109	R106
CR110-30 / 0V	MAC3-4	C80B	100, 1/2W, 10%	3K, 3W, 3%
CR36-100 / 0V	MAC3-2	C80F	33, 1/2W, 10%	1.5K, 3W, 3%
CR20-150 / 0V	MAC3-2	C80F	10, 1/2W, 10%	800, 3W, 3%
CR65-55 / 0V	MAC3-4	C80B	47, 1/2W, 10%	2K, 3W, 3%

SYM	DESCRIPTION	DATE	APPR.
T	ADDED R27 - NOTE 11, 12 IN PARALLEL - ECN 4228, 5358	3-3-71	
U	CR 16 WAS IN4384 ECN 5442	12-17-71	
V	ADDED C30, 31, 32 - ECN 5557	9-29-72	

SYM	DESCRIPTION	DATE	APPR.
K	CR23-55, CR110-30, CR24, 25, 23, 26, WAS IN3249A, CR20-150, CR36-100, CR65-55, WERE IN3289A, CR18-19, WERE IN4384 ECN 4264, 3601	7-10-69	
L	ECN NOS 4918 - 4949	7-10-69	
M	CR11 WAS CR65-55 (A) ADDED TO CR10-2 IN1341 RC CR20 & 22 WERE C30B - ECN 4501	7-31-69	
N	CR20, 21, 22 WERE C60 BOV, MODEL C65-55 - ECN 4989	5-27-70	
P	CR20, 21, 22 WERE C60 BOV MODEL C36-100 - ECN 5013	6-17-70	
Q	R60 WAS 100, 2W MODEL CR20-150 ECN 5118	11-19-70	
R	IN CR110-30 R30 WAS 12K 8W ECN 5196	12-28-70	
S	SEE SHT. 1 OF 3 - ECN 5160	2-16-71	
T	SEE SHT 1 OF 3 - ECN 5201	3-3-71	

ZONE	REVISIONS	DATE	APPROVED
A	REVISED PER ECN NO 3177-SEE SHT 2	3-17-66	
B	REVISED PER ECN 3297	6-14-66	D.R.M.
C	REVISED PER ECN NO 3361, 3375 & 3380 - SEE SHT 1	8-19-67	W.J.
D	ADDED CR CIRCUIT PER 3612	11-2-68	R.P.
E	SEE SHT 1 OF 3 - ECN'S 3638, 3644, 3718	2-27-69	R.G.
F	CR23-CR25 WERE MER2175BE (CR110-30) & MER2135BE, R500 WAS C80B - ECN-3846	3-28-69	R.E.
G	SEE SHT. 1 OF 3 - ECN'S 3865, 3866, 3867, 3868	8-22-69	R.P.
H	SEE SHT. 2 OF 3 - ECN 3922	6-27-69	G.R.
J	DELETED CR36-100/440 FROM LIST - ECN 3947	6-26-69	R.P.

CATHODE CR8

R100 3.01K 1% · R101 680 2W · R102 220 1/2W · Q101 2N4238 · CR107 TR4148 · CR100 TR4148 · CR101 TR4148 · C100 25 50 · Q102 TR2905 · R103 3.3K 1/2W · R104 10K TYPE 100 · R4 SIDE 1 · R4 SIDE 2 · +S · CR102 IN751A · +V · L2 501380 · CR104 MR12-20SL · R105 1K 1/2W · CR106 IN4384 · R106 · A1 · A2 · G · CR103 · R109 · R108 250 10W · CR105 · R107 470 1/2W · -V

OPTIONAL OV. CIRCUIT

TO GATING CIRCUITRY

T2 ecb · T3 eba · T4 eac · DS1 · DS2 · DS3 · (3) ST50-2-2 · K1 · TS154-CC-CC 760275

C25 .05 200V · C26 .05 200V · C27 .05 200V · CR20 · CR21 · CR22 · R59

B2 · B1

AND POWER CIRCUITRY

TO AMPLIFIER

DS4 · R60 · CURRENT ADJUST · R55 · R54 · R53 · R51 SHUNT · M1 · M2 · R27 2K LOAD SHARE ADJUST · AUTO PARALLEL · PARALLEL · R49 100 2W · VOLTAGE VERNIER · R50 · VOLTAGE ADJUST · +S · +V · -V · C12

Q13 · Q14 · Q15 · R58 .150 3W · Q12 · CR17 IN4384 · CR18 IN4384 · CR19 IN4384 · CR71 U-806 · R57 · R56 · R52 · C13-17

CBI · ØB · N · ØA · ØC · TBI · T1 · CR26 · C31 250V · C32 250V · C30 250V · CR23 · CR24 · CR25 · L1

10 GND · 2 RVP · 8 -S · 9 -V · CR16 5JUS

QTY REQD	SYM	NOMENCLATURE OR DESCRIPTION	CODE IDENT	PART OR IDENTIFYING NO	SPECIFICATION	MATERIAL OR FINISH	UNIT	NOTE

LIST OF MATERIALS OR PARTS LIST

CR110-30	CR110-30-1	CR110-30-2	11900 150V	720126R	C50C	0-30A	0-160V	3263S 30A	(2)705OW IN SERIES	1.67 3W	2N3442	1500 25W	0.033	12K 4W	720126R	100 2W
CR65-55	CR65-55-1	CR65-55-2	37600 75V	720126R	720040	0-100A	0-100V	3363S 35A	(2)750W IN PAR.	.7 3W	700080	4K 10W	0.02	7.5K 2W	720126R	100 2W
CR36-100	CR36-100-1	CR3 -100-	78000 45V	720124R	720040	0-100A	0-40V	3263S 35A	1100 150W	0.3 5W	700080	700 10W	0.01	4.5K 2W	IN3262R	100 2W
CR20-150	CR20-150-1	CR20-150-2	115000 25V	720124R	C60A	0-150	0-20V	3263S 30A	4 150W	0.2 10W	700080	300 10W	0.0067 (2)IN PAR.	2.5K 2W	IN3262R	50 2W
MODEL	T1	L1	C12-C17	CR23-CR25	CR20-CR22	M1	M2	CB1	R53-R55	R52, R56 & R57	Q12-Q15	R58	R51 (SHUNT)	R50	CR26	R60

NEXT ASSY	USED ON	APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES

MATERIAL:

FINISH:

DRAWING STARTED	DATE	
DRAWN	12-23-66	
CHECKED		
ENGR.	1-10-67	

TRYGON ELECTRONICS INC.
ROOSEVELT NEW YORK

MODEL CR SERIES

SCHEMATIC (ROVER CIRCUITRY)

IDENT NO	SIZE		
09206	D	8237	F3

SCALE: 3-0F

6 5 4 3 2 1

MP MASTER
MA34097